2008 Implementation and Effectiveness Monitoring Results for the Washington Conservation Reserve Enhancement Program (CREP)

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Introduction

The Conservation Reserve Enhancement Program (CREP) is a voluntary program that offers financial incentives to farmers to restore riparian habitat and preclude agricultural activities in those buffers during the contract duration (10 or15 years). The program began in 1998 with the first signed contracts in 1999, and is cooperatively administered by the U.S.D.A. Farm Service Agency (FSA) and the Washington State Conservation Commission. The federal government pays for approximately 80% of the total costs.

Much of Washington State has stream drainages that provide habitat for salmon and steelhead that are listed as threatened or endangered under the Endangered Species Act (NOAA Fisheries Service 2008). Degraded riparian habitat is one of the major factors limiting recovery of these listed species (Washington State Governor's Salmon Recovery Office 2008). About 37% of salmon streams on private land pass through agricultural land use (USFWS and NMFS 2000), and because much of the agricultural land is located in or near historic riparian/floodplain-rich habitat, it is important that efforts continue to develop opportunities to not only improve riparian habitat for healthy watersheds, but also to maintain viable agriculture. Once land is converted to more intensive development (urban and industrial), the prospects to preserve or restore habitat near streams greatly decrease and environmental impacts increase. Between 1982 and 1997, about 20% of the farmland in the Puget Sound region was lost to other uses, especially in King and Snohomish Counties where urban growth has been high (Canty and Wiley 2004).

The primary focus of the Washington CREP is riparian buffer restoration and protection, and to ensure accountability and success, the Washington CREP is monitored by the Washington State Conservation Commission for program implementation and effectiveness. This monitoring allows the managers to track what's been done, where it has been done, and how successful the investments and various techniques have been. It also provides the basis for adaptive management to increase future success of the program.

Implementation monitoring of CREP tracks how much has been done, such as acres treated, stream miles restored, number of contracts, feet of fencing installed, and number of plants planted. Effectiveness monitoring assesses whether the project was successful, i.e. did the contract result in a successful riparian buffer in terms of plant growth, survival, diversity, percent shade, bank erosion, and non-native plant species control.

There are two levels of effectiveness monitoring (SRFB 2003). Level 1 monitors whether or not the site is still meeting design criteria. In the case of riparian restoration, this includes parameters such as plant growth, plant survival, and plant diversity. Level 2 effectiveness monitoring assesses whether or not a desired outcome occurred at the reach level, such as increasing stream shading and controlling bank erosion (SRFB 2003). Both levels of effectiveness monitoring were conducted on CREP contracts.

The proposed methodologies are consistent with the Washington State Governor's Forum on Monitoring recommendation to use protocols compatible with the Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) of probabilistic sampling (Peck et al. 2001). Site selection occurred via random sampling of existing CREP sites.

Purpose of Project

The purpose of this project is to evaluate the current status of riparian buffers developed under the CREP program in Washington State. How many stream miles, buffer acres, contracts, plants, and feet of fencing being installed? Are the contracts meeting design specifications such as standards for growth, survival, and buffer diversity? Are the contracts effective in their desired functions of increasing shade, controlling bank erosion, and controlling non-native plant species?

Methodology

Following EMAP protocols, 18 sites were randomly selected for field measurements for 2008 with a goal of sampling 17 to 20 sites annually over a ten-year period. Randomization was accomplished using the Research Randomizer (2005), and only areas that implemented full restoration were included. Sites that significantly filled-in plants under a pre-existing canopy were not included as they would skew the results in a favorable manner. For the analyses, all measurements were grouped according to the number of growing seasons. Both types of effectiveness monitoring measures (Level 1 and 2) are described in detail below.

Level 1 Effectiveness Monitoring

Data were collected to answer the following Level 1 effectiveness monitoring questions by contract site, by growing season, and by eastside versus westside. Plant type is defined as conifer trees, deciduous trees, shrubs, or grasses although grasses were not measured. Separating by plant type reduced some of the plant growth variability.

- What is the growth rate of plants by type and by region?
- What is the percent survival of plants by site and by region?
- What is the plant species diversity by site and by region?

The field measurements for the Level 1 effectiveness measures followed the strip-plot design methodology described in Haight (2002). This design is a good choice for assessing a diverse buffer that often has differing conditions near the shoreline versus further upland. Details on setting up the strip-plot are described below. These 20-foot wide strips encompassing the buffer width were assessed for:

- Species of plant
- Plant type (conifer, deciduous, shrub, grass)
- Height of plant (ground to tip of plant) using a laser rangefinder or measuring tape/stick.
- Live/dead/missing status for each plant (sometimes missing plants are obvious, but other times are not and could be under-recorded)
- The number of plants total, by plant type, and by species per square foot of sampling area.
- Presence of non-native invasive plants and extent of coverage (area of plot)
- Notes about the site, such as predation, flooding, fire, and other issues.

The plots were at equally spaced intervals (100’) beginning at a random start near the edge of a project and extending through the project site in areas that don’t have significant interplanting. Because some sites have buffer lengths approaching 20,000’, it wasn’t feasible to treat large sites as a single site, and for those with distinctly different sections or parcels, one parcel would be randomly selected for sampling.

After the interval start point was found, the strip-plot was set up as follows. A tape was run through the buffer width perpendicular to the stream to create the perpendicular tapeline. The tape was secured, and the buffer width (length of tape) recorded for later calculations of sample area (tape length (buffer width) X 20’). All CREP plants within 10-feet of each side of the tapeline were assessed. This has been shown to be a statistically valid yet efficient plot design for riparian buffers of varying ages (Haight 2002). Borderline plants were included if half or more of their trunk radii at diameter breast height (Dbh) (generally 4.5’) was within the 10’ mark.

In addition, data were obtained from the planting records regarding the original height of plants by species and the date of planting to determine the number of growing seasons. Any replanting or thinning data was also recorded.

Data were entered and stored in the Conservation Practice Data System at the Conservation Commission. Data were grouped by plot, project, district, region (eastside/westside), and state to summarize at various levels. Plants were grouped by species and type.

Level 2 Effectiveness Monitoring

Level 2 effectiveness monitoring involved in-channel measurements of percent canopy cover and bank erosion. These were measured in the stream channel as an extension of the mid-point of the buffer plot described above.

The questions answered include:
What is the percent canopy cover by site, by region, and by growing season?
What is the percent bank erosion by site, by region, and by growing season?
How does each of these measurements change with age of project (number of growing seasons)?

Percent Shade (canopy cover) Measurements. The percent canopy cover was used to estimate shade following EMAP protocols (Peck et al. 2001). At each instream transect, the percent canopy cover was measured using a convex spherical densiometer. Six readings were taken at each transect of wadeable streams. They included: the bank treated in CREP and four readings in the mid-channel (upstream, left bank, downstream, right bank). The transects were averaged for an overall site score. A score of 1-17 was given to each site and the score was divided by 17 to obtain the percent of canopy cover. Non-wadeable streams were not assessed for canopy cover.

Bank Erosion Measurements. The bank erosion condition was estimated by visually assessing the 20' length of bank (same side as CREP contract) centered on each in-channel transect (10' from each direction of transect point). The assessment included noting the percent of bank eroded, the percent of bank lacking vegetation, and the number of slides entering the stream.

Data Analysis

Differences between groups were determined using analysis of variance (ANOVA) or Student's T Test.

Results

Implementation Results

Implementation Monitoring: New Contracts

The Washington State CREP agreement was signed in 1998 with the first contract implemented in 1999. Since then, the program has installed a total of 790 contracts with landowners (Figure 1). In 2008, 53 contracts were signed, which is an increase from the 34 contracts signed in the previous year (Figure 2). One limitation to the number of new contracts is available staff time at each Conservation District because district staff must also manage older contracts that still require maintenance. Contracts are under an active 5-6 year maintenance period after implementation, and during this time, district staff must inspect each contract and develop appropriate maintenance plans.

To account for a more accurate workload, the number of managed contracts was assessed. This includes both new contracts and contracts eligible for maintenance. In the last four years, the number of managed CREP contracts has been at high levels, ranging from 600-700 (Figure 3). Although the peak of new contracts occurred from 2001-2003 (Figure 2), those contracts are just now maturing out of the active maintenance period, freeing district staff time to increase the number of new CREP contracts.

Figure 1. The total number of signed CREP contracts by year in Washington State.

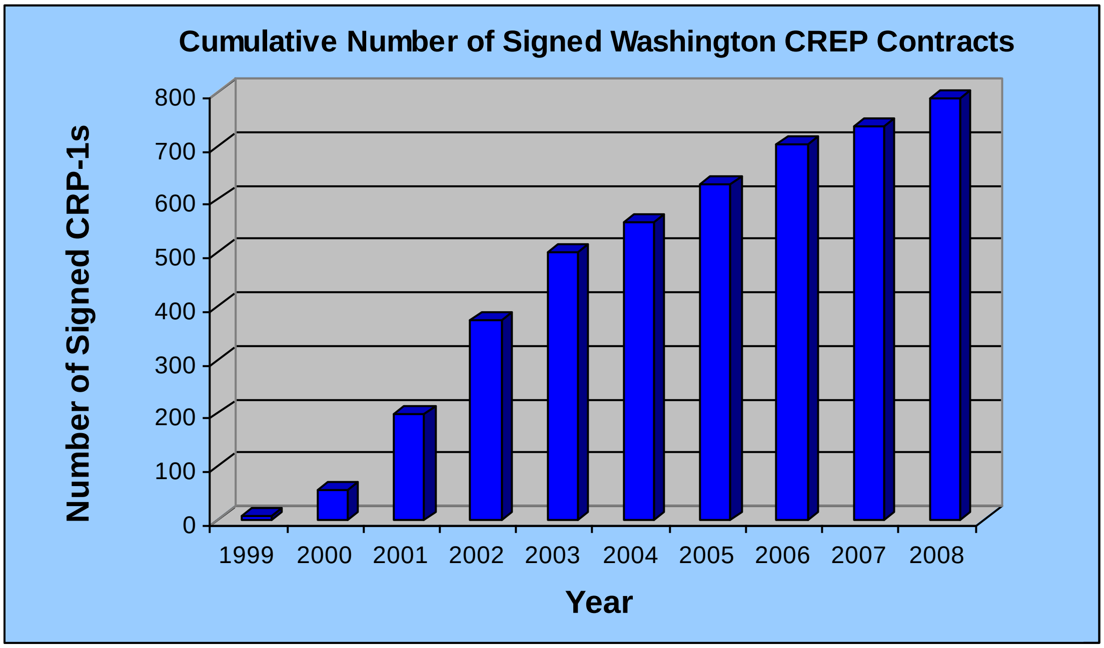


Figure 2. The number of signed contracts each year in the Washington CREP.

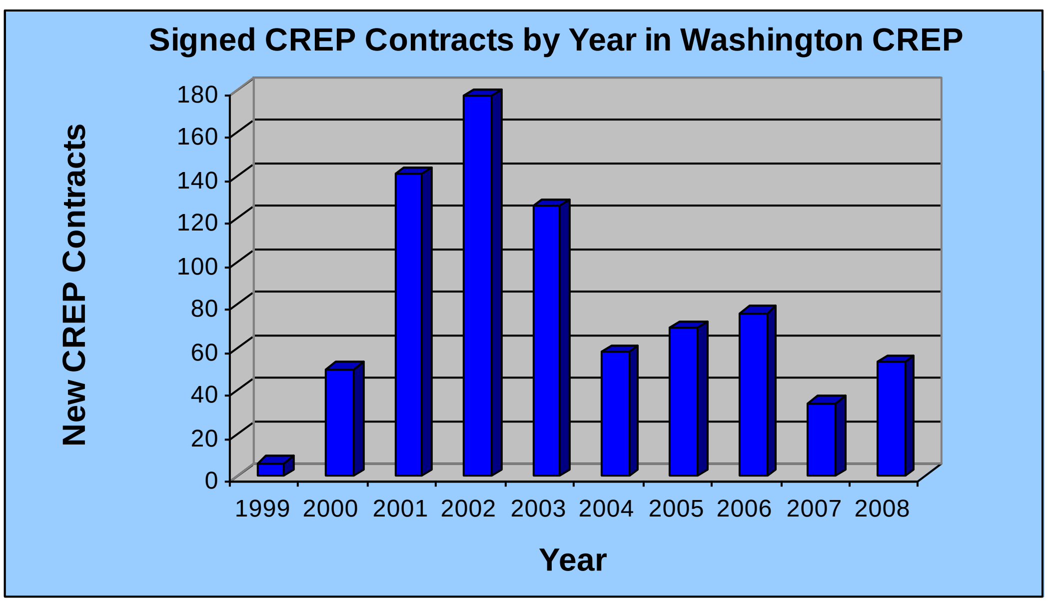
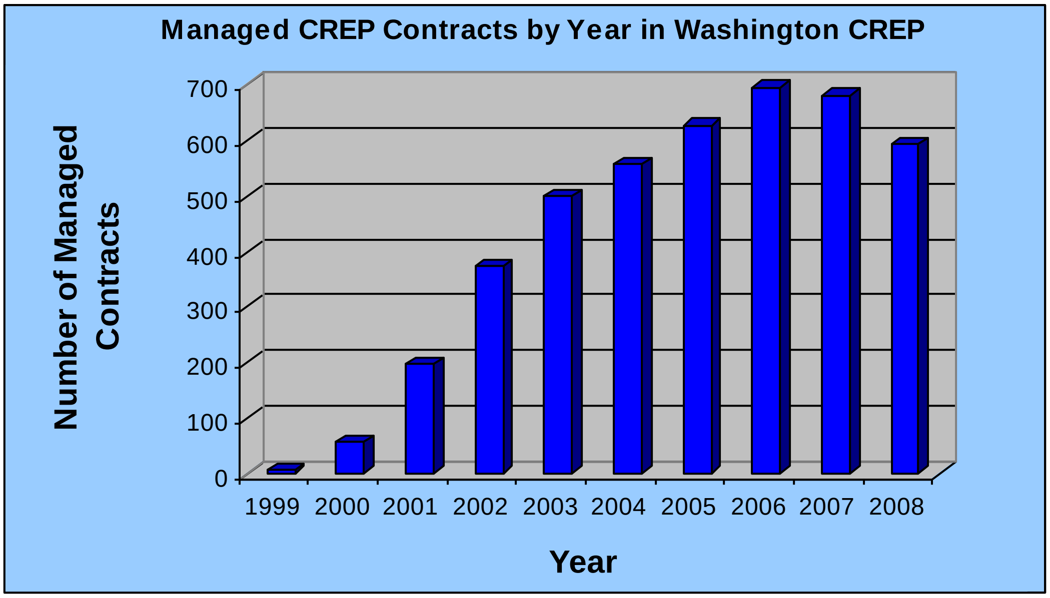


Figure 3. Number of managed contracts for each year of the Washington CREP. Managed contracts include new contracts and contracts eligible for maintenance.



Implementation Monitoring: Riparian Benefits

In 2008, 28 additional stream miles were restored and protected in the Washington CREP, bringing the total number of stream miles under contract to 624 (Figure 4). Buffer acres increased by 601 with a total of 12,070 acres of riparian buffer protected with CREP contracts (Figure 5).

Figure 4. Total cumulative stream miles restored and protected in the Washington CREP.

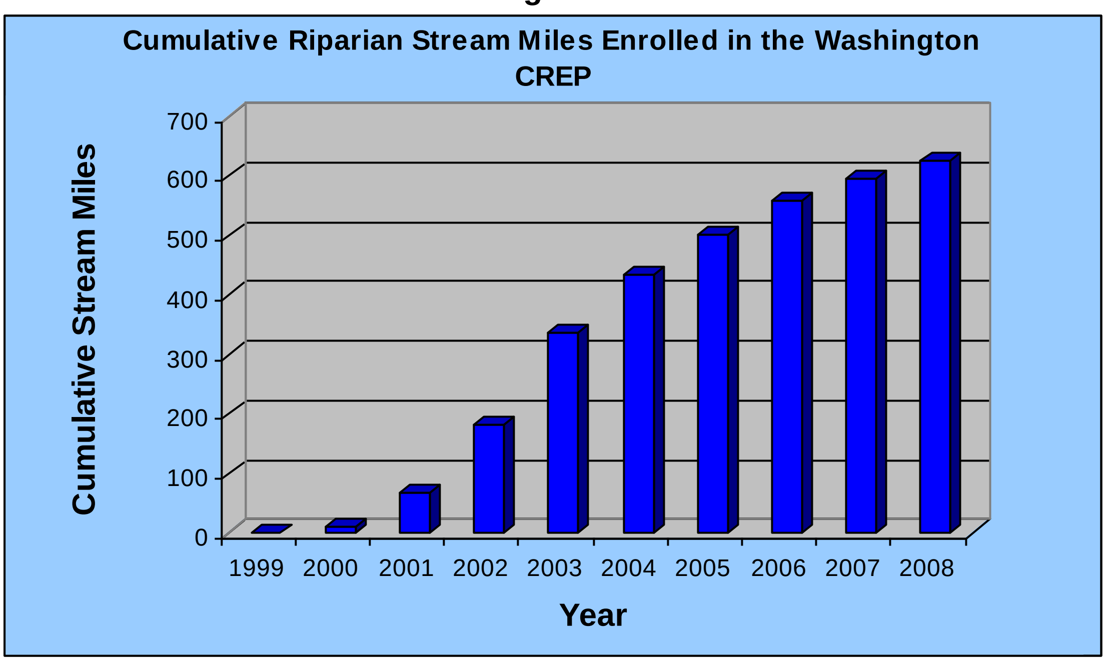
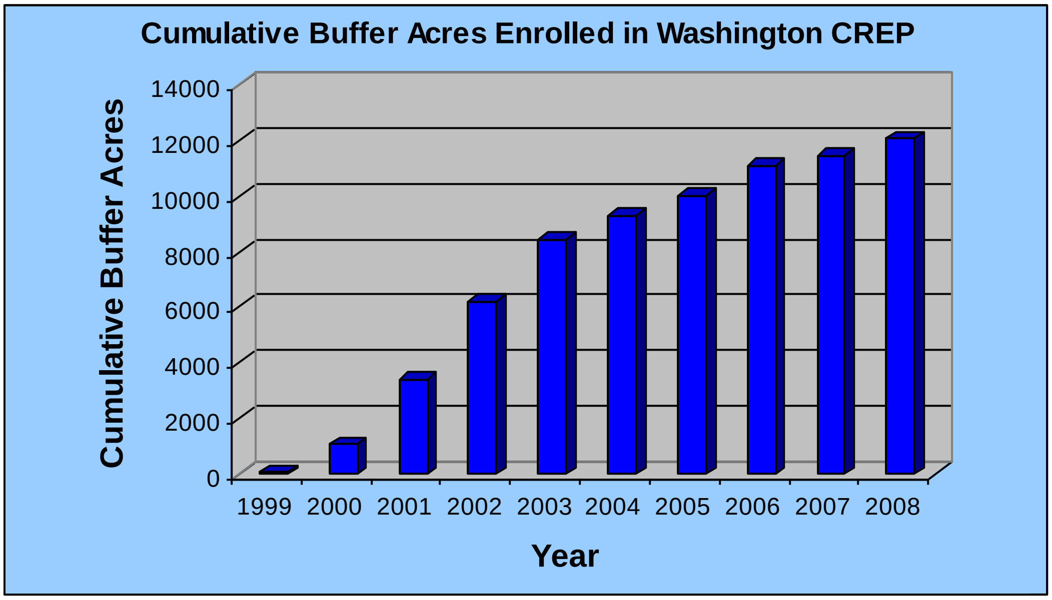


Figure 5. Total cumulative acres of riparian buffer enrolled in the Washington CREP.



Implementation Monitoring: Seedlings, Troughs, and Fencing

Over 207,000 seedlings were planted in 2008 for a total, cumulative level of nearly 4.7 million seedlings planted throughout the last nine years of CREP (Figure 6). In addition, a total of over 1.3 million feet of fencing has been installed along CREP riparian buffers to exclude livestock from these sensitive areas with about 94,000 feet installed in 2008 (Figure 7). Lastly, a total of 188 watering facilities have been installed in CREP over the last nine years to facilitate livestock exclusion from salmon streams (Figure 8).

Figure 6. Total, cumulative seedlings planted in the Washington CREP.

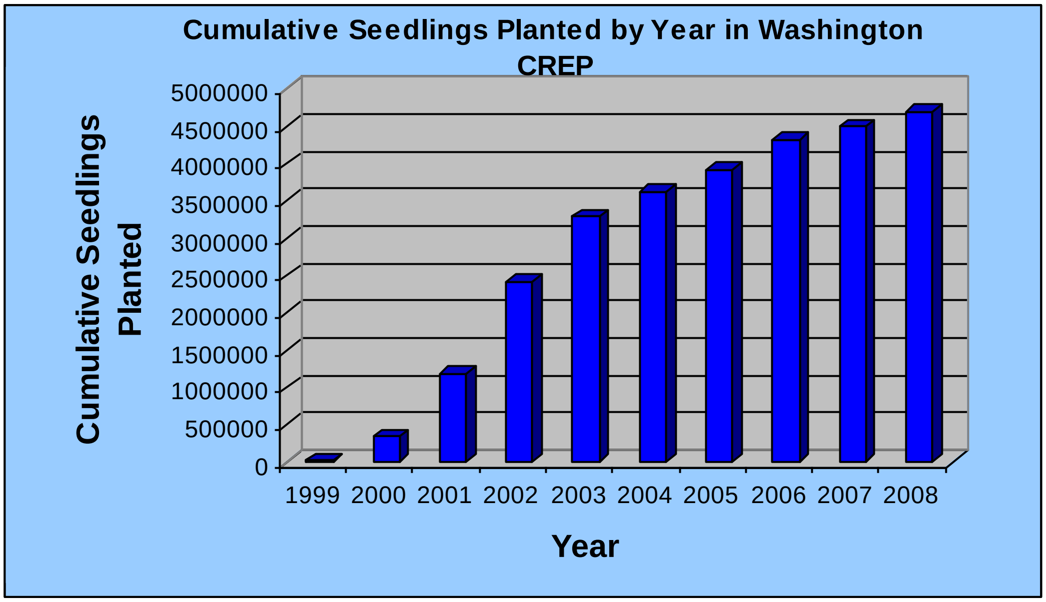


Figure 7. Total, cumulative feet of fencing installed in the Washington CREP.

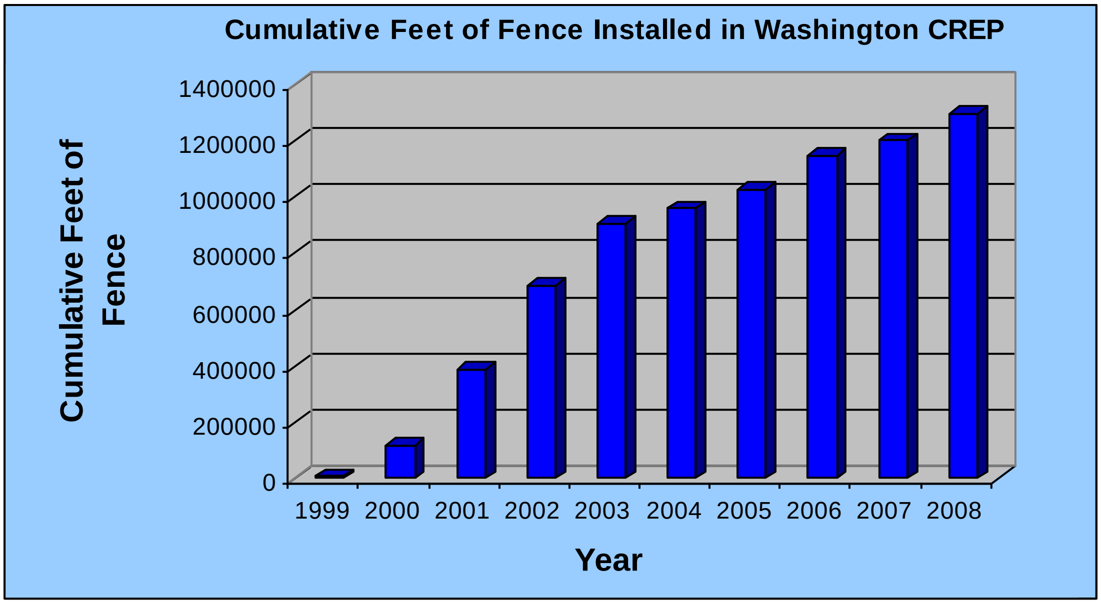
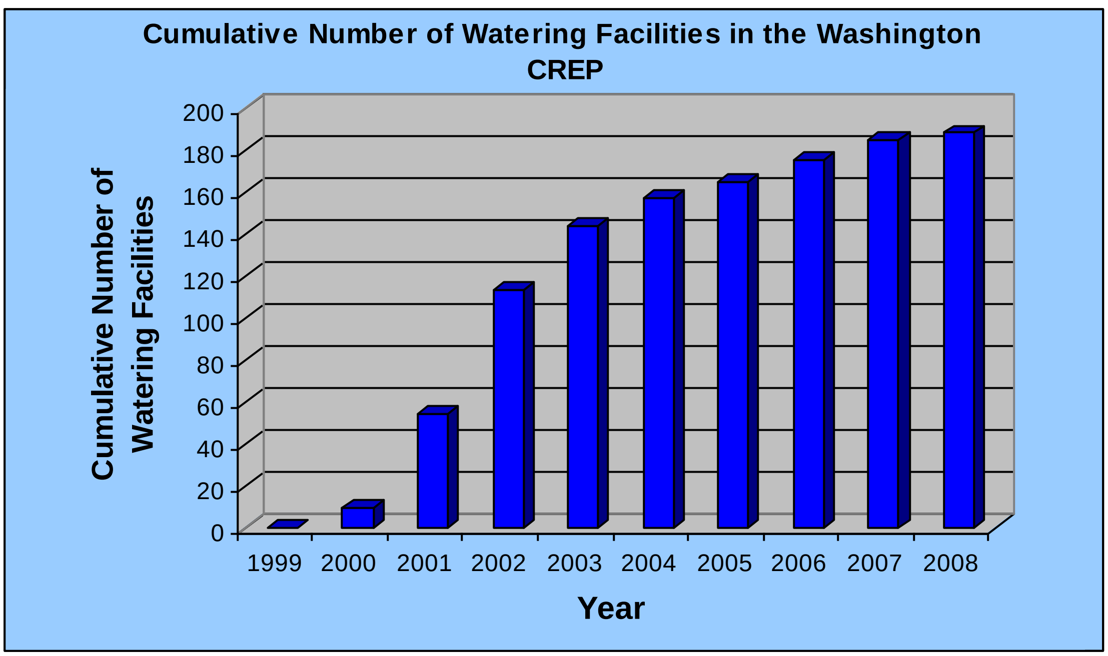


Figure 8. Total number of watering facilities such as troughs and wells installed in the Washington CREP.

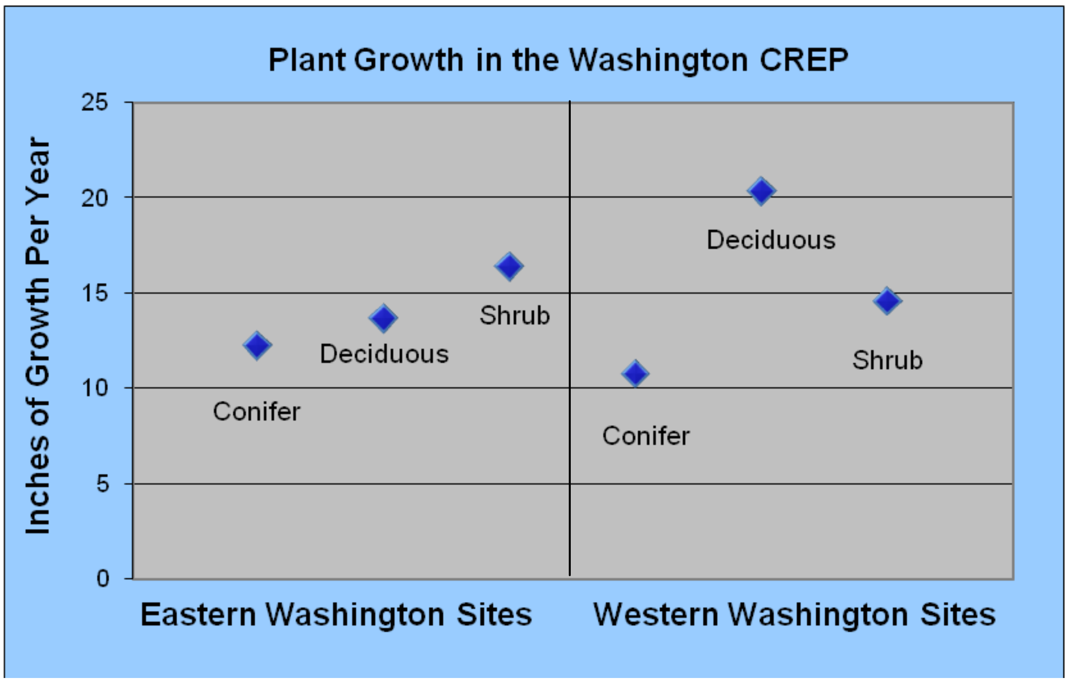


Effectiveness Results

Effectiveness Monitoring: Plant Growth

At the eastern Washington CREP sites, conifer (ponderosa pine) and deciduous plants grew at an average of 12.3 and 13.7 inches per year, respectively, while shrubs (mostly willow) grew an average of 16.4 inches per growing season (Figure 9). In western Washington, conifers and shrubs grew at an average of 10.8 and 14.6 inches per year respectively, and deciduous trees grew at a mean of 20.3 inches per growing season (Figure 9). There were no significant differences between any of these groups using ANOVA (P=0.559).

Figure 9. Plant growth per year of installed plants in the Washington CREP.



Effectiveness Monitoring: Plant Survival

Survival of CREP plants at eastern Washington sites is shown in Figure 10 with a mean survival across sites of 83 percent and a median survival of 88 percent. Western Washington CREP plant survival is shown in Figure 11 with a mean and median of 87 percent. There was no significant difference between these two groups using the Student's T-Test (P=0.6319).

Figure 10. CREP plant survival at sites in eastern Washington.

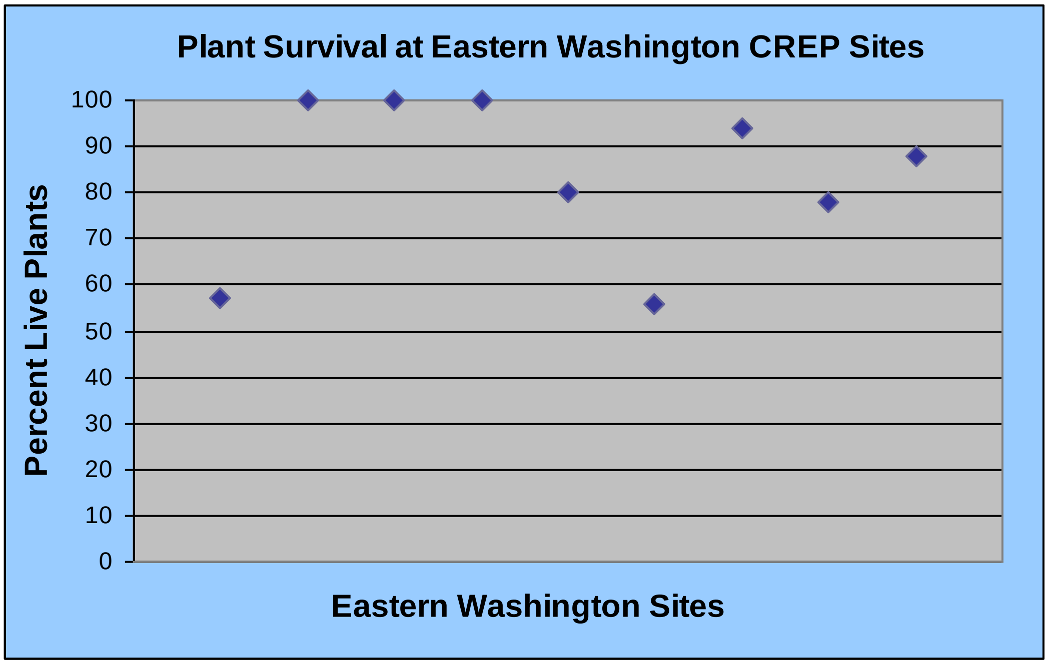
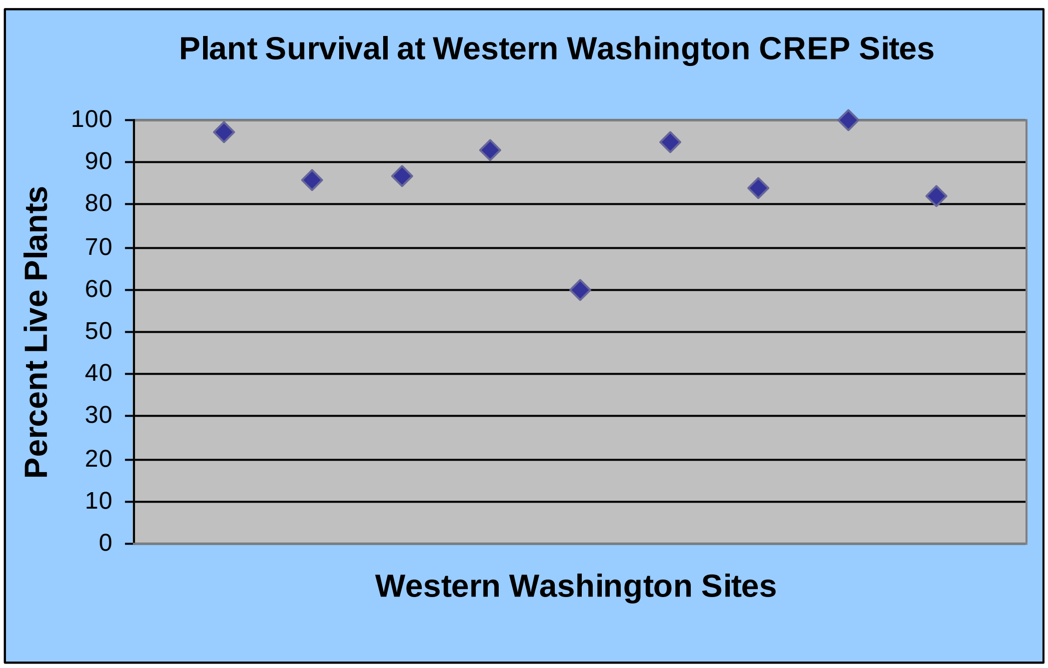


Figure 11. CREP plant survival at western Washington sites.



Effectiveness Monitoring: Plant Diversity

Plant diversity as a partial sample, ranged from one to twelve species per site in eastern Washington (Figure 12). Variability was large with most sites having five or more plant species within the sampling plots. Plant species diversity was significantly greater (P=0.0208) in western Washington with a range of five to fifteen species within the sampling plots of a given site (Figure 13).

Figure 12. Number of plant species per sampled CREP site in eastern Washington.

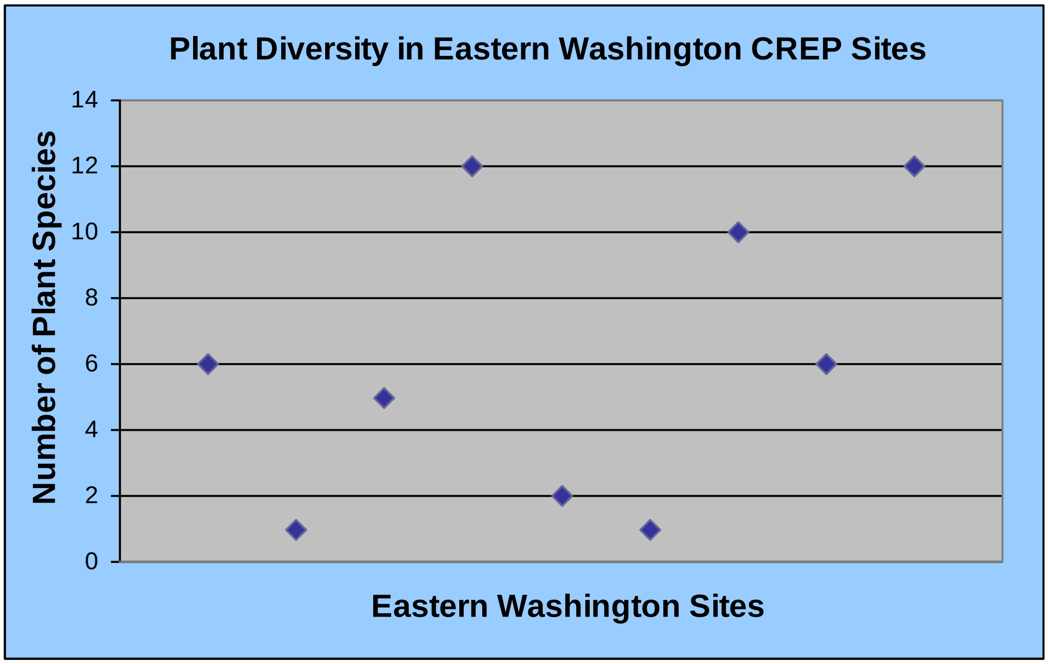
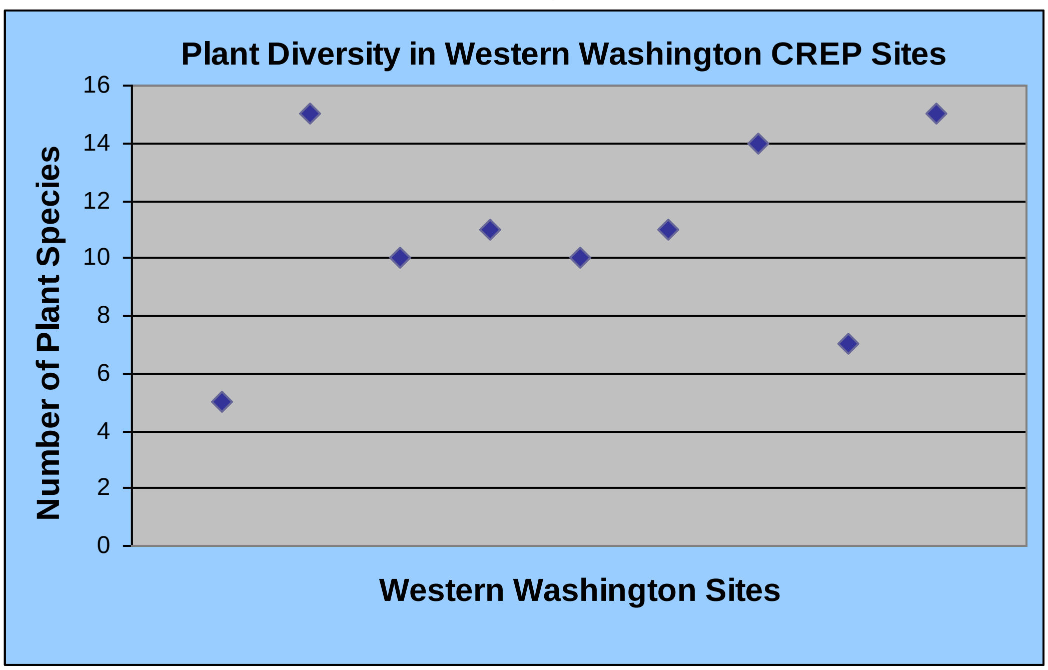


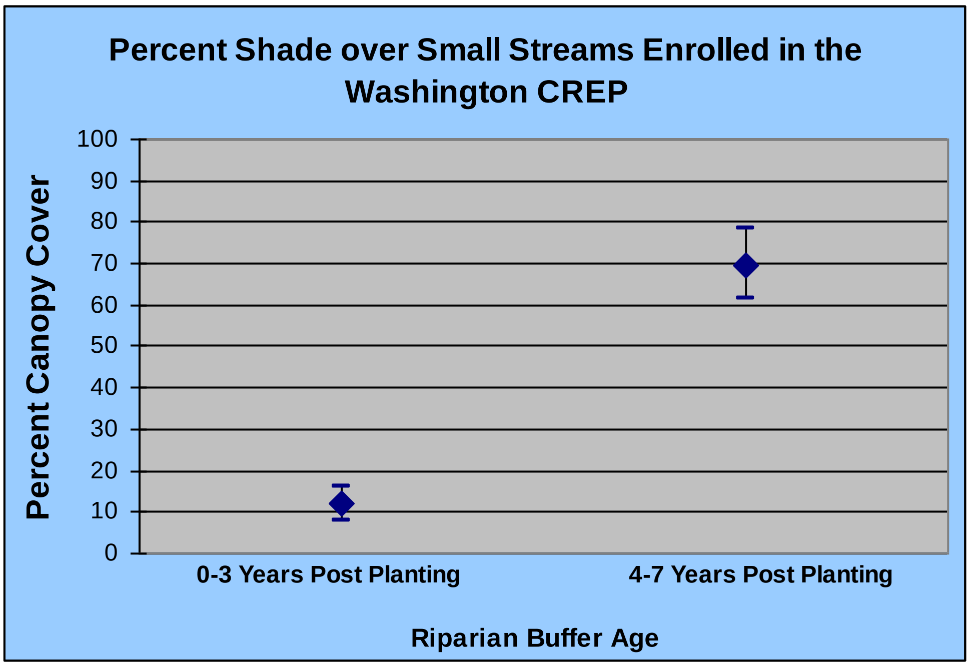
Figure 13. Number of plant species per sampled CREP site in western Washington.



Effectiveness Monitoring: Canopy Cover

The amount of shade over the CREP-planted stream reaches was estimated as percent canopy cover. This was measured only for the small, wadeable CREP stream reaches because the larger mainstem reaches were not able to be sampled mid-channel. For the small streams, shade significantly increased (P=0.0009) over the CREP reaches that were planted at least 4 years prior as compared to younger CREP sites (Figure 14). These results are not applicable to wider streams as those are more difficult to shade and require a combination of wide buffers and more mature trees. If canopy cover were measured for the wider streams, the results would likely be much more variable and less significant between the two age groups.

Figure 14. Percent canopy cover over small (wadeable) CREP enrolled-stream reaches that were sampled in 2008.



Effectiveness Monitoring: Bank Erosion and Extent of Invasive Species

The percentage of eroding banks was low in the eastern Washington CREP sites with an average of 3.7 percent across sites and a maximum of 15 percent at one contract site (Figure 15). Most sites had no bank erosion in the sampled areas. In western Washington, most sites also had no bank erosion, but one site with 43 percent bank erosion raised the mean to 9 percent bank erosion across sites. The site with a high percentage of bank erosion was subjected to a large flood event the prior winter. There were no significant differences between eastside and westside sites (P=0.3661) or between 0-3 year planting seasons and 4-7 year sites (P=9452).

Figure 15. Percent bank erosion along CREP reaches in eastern Washington.

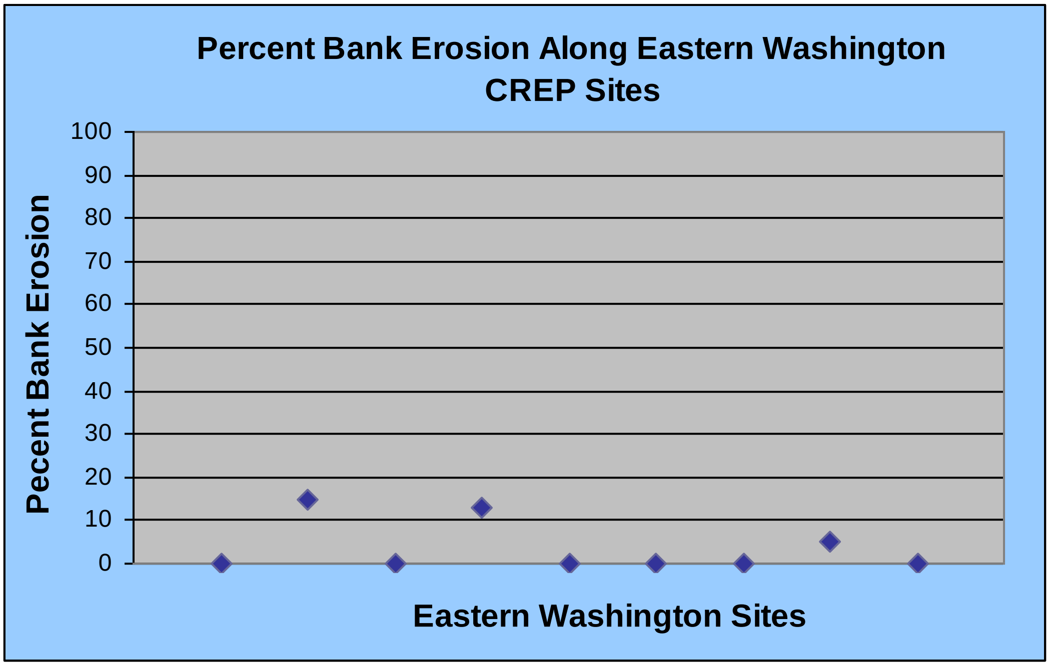
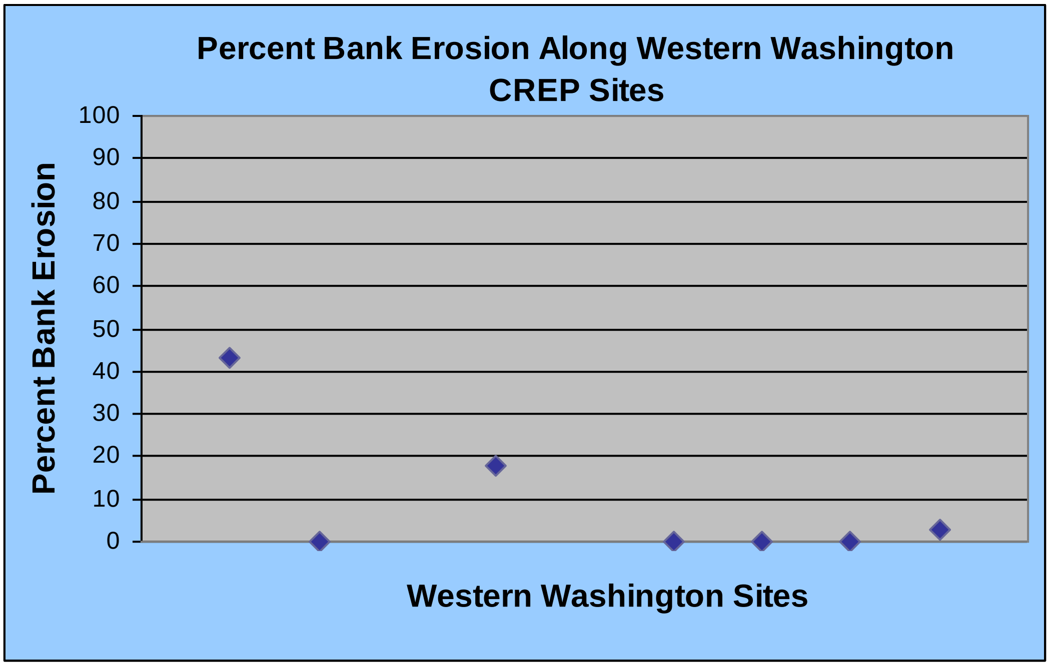


Figure 16. Percent bank erosion along CREP reaches in western Washington.



The percent of land coverage by invasive plant species averaged 3.8 percent for younger (0-3 growing seasons) and <1 percent for older (4-7 years) contracts. There were no significant differences between these two groups (P=2917).

Discussion

Plant Growth

The CREP plants in Washington State are growing at rates that are generally greater than documented elsewhere. Growth rates are high for both the arid regions in the east and the wet areas of the west with no significant difference between the two regions in growth. Comparing the growth of these sites to those in the literature was difficult because most literature sources do not focus on the first five years of growth, the more common current age of our projects. When comparing to the available information, the CREP sites are meeting or exceeding expectations.

For conifer growth, 1+0 Douglas fir plugs and 2+0 bareroot grew 4.2 inches and 4.3 inches per year after two years, respectively in western Oregon (Helgerson 1985). Ponderosa pine grew 4.1 and 4.7 inches per year for plugs and bareroot. In another study, mixed age conifers grew an average of 1.92 inches per year for Douglas fir and 2.62 inches per year for western hemlock along the Pacific coast (Hann et al. 2003). British Columbia reported riparian conifer growth rates of 6.1 to 17.6 inches per year (Poulin and Warttig 2005). Most of these growth rates are lower than our conifer rates of 10.8 inches per year in western Washington and 12.3 inches per year in eastern Washington.

CREP deciduous tree growth averaged 20.3 inches per year in western Washington and 13.7 inches in eastern Washington, and shrubs grew an average of 14.6 inches per growing season in western Washington and 16.4 inches per year in eastern Washington. In a similar restoration project in western Oregon, red alder grew an average of 39.4 inches per year (Bishaw 2002). In another study in British Columbia, black cottonwoods (one of the fastest growing deciduous trees) grew an average of 66 inches per year over a ten-year period (Burns and Honkala 1990). Pacific willow, a commonly used small tree in CREP projects, averaged 13.2-36 inches per year in Corvallis, Oregon (USDA Soil Conservation Service and Oregon State University Agriculture Experiment Station 1988). Sampled Washington CREP contracts included many different types of deciduous trees including big-leaf maple, red alder, black cottonwood, Pacific willow, ash, birch, oak, and cascara. The species diversity could account for lower growth rates than those documented in other areas that focus only on the fastest growing species.

While there are no set standards for plant growth in CREP, we consider sites successful if the growth/year of CREP plants plus the original height are showing a 20% increase compared to the original height. All of the sampled CREP plant types (conifer, deciduous, and shrub) in both regions greatly exceeded this measure of success.

Plant Survival

Plant survival was excellent at nearly all of the sampled CREP sites. The median percent survival was 88% in eastern Washington and 87% in western Washington. Mean survival was 83% in eastern Washington and 87% in western Washington. In general, CREP plant survival in Washington has been very successful with only three sites experiencing moderate losses (56-60% survival) and the remaining 15 sites having near 80% survival or greater. Two of the three sites with moderate losses were located in eastern Washington, and the cause was likely the result of drought conditions, while the cause for the single site in western Washington with a moderate loss is unknown, but was limited to a single species.

Survival results differ greatly in the literature, and depend heavily on weather patterns and environmental conditions, which can vary locally. In an Oregon study, survival of conifers averaged 98% for bareroot stock and 89% for plugs after two growing seasons (Helgerson 1985). However, in a recent restoration project along Beaver Creek in Oregon, survival was about 50% during the first year (due to beaver damage), but after providing better protection, increased to a range of 67-75% after three years (Bishaw et al. 2002). A riparian project in the Oregon high desert reported early survival results of 70-80% for a mix of ponderosa pine, deciduous trees, and shrubs (Fox Creek Farm 2006).

The Salmon Recovery Funding Board (SRFB) in Washington State defines plant survival as successful when survival is 50% or greater at year 10 (Crawford 2004). None of the sampled CREP contracts were that old, but most of the sites in this year's sample will likely exceed that standard as mortality is often greatest in the first few years after planting. The NRCS plant stocking specifications assume a15-20% mortality within the first few years, and the majority of Washington CREP sites are generally performing better than these assumptions.

Plant Diversity

Plant species diversity can have a valuable role in riparian buffers by providing a wide array of wildlife habitat and ecological benefits. In addition, different types of vegetation have varying levels of effectiveness for riparian functions. For example, grasses are the most effective vegetation type to trap sediments and filter pollutants (Fischer and Fischenich 2000). They have a moderate ability to prevent bank erosion and a low effectiveness for bank failure prevention and habitat formation. In contrast, trees have a high effectiveness for forming habitat and preventing bank failures with a low to moderate ability to prevent bank erosion, trap sediments, and filter pollutants (Fischer and Fischenich 2000). Shrubs have the highest effectiveness for bank stabilization, a medium ability to trap sediments, prevent bank failures, and provide habitat with a low effectiveness for filtering pollutants. The most effective riparian buffers will ultimately have a mix of plant types as they mature. Diversity is a characteristic that develops over time in natural forests. Old growth forests are much more heterogeneous than young forests (Franklin et al. 1981).

The sampled CREP sites had generally good plant diversity, although specific standards do not exist. The westside sites averaged 11 species per contract, while the eastside averaged 6. Lower species diversity is expected in the more arid regions of the state, such as found in the eastside.

Stream Reach Shade and Bank Erosion

The wadeable CREP streams showed a surprisingly large significant difference in canopy cover between younger (0-3 growing seasons) and older (4-7 seasons) sites. Younger sites averaged 12 percent canopy cover, while older sites averaged 69.8 percent. These results are dependent on the stream width, which was less than 15 feet bank-full width for the sampled streams. The larger streams were not sampled due to safety concerns, and observations from those sites suggest that canopy cover results would have been much more variable and less significantly different if larger streams were sampled for this parameter. However for small streams, these results demonstrate that CREP buffers are quickly effective at providing canopy cover.

Bank erosion was generally very low with an average of 3.7 percent along the sampled eastside contracts and 9 percent along the westside projects. The higher value in the westside is due to a single contract that experienced a record-breaking flood the previous winter. This part of the state was declared a federal disaster area because of the flood. The percentage of bank erosion did not seem to depend on the age of the contract or whether it was located in the eastside or westside. It is not surprising that bank erosion values were low even for young contracts, as sites are not eligible for CREP if they have significant levels of bank erosion.

Invasive species coverage was also very low with a mean of 3.8 percent in the eastside to less than 1 percent in the west. CREP contracts are inspected regularly for at least 5 years after planting and funding is provided during that crucial time of establishment to control invasive plant species. The five years of intensive maintenance is likely the reason for the very low presence of invasive plant species within CREP buffers.

These results demonstrate that CREP buffers are successfully growing and surviving with generally rich plant species diversity. The small streams are quickly buffered with shade, and the five-year maintenance program appears to be successful in controlling invasive plant species and is also necessary for irrigation and other issues that impact plant establishment.

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